Speech input interfaces for anaesthesia records

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1 The anaesthesia record

During a medical operation requiring full anaesthesia, anaesthesiologists have to register their main acts (e.g. medications, gases) on a time-line in the anaesthesia record along with key physiological data (e.g. pulse, blood pressure). While the anaesthesia record is required for legal reasons, its real importance relates to patient safety: it supports anaesthesiologists' memory (e.g. medications administered), team communication and planning, as well the briefing of additional staff who join the team during operation. Nevertheless, taking care of the patient here and now is always the primary task, while keeping the anaesthesia record updated necessarily has a much lower priority.

Nowadays, electronic anaesthesia information management systems have increasingly been replacing the traditional paper records. For instance, 63% of the anaesthesia departments in Denmark were already using electronic anaesthesia records in 2004 [1], with a user interface typically built around a touch-screen and a keyboard. Electronic systems have solved some of the problems of the former paper-based records; in particular, automatic registration of the vital signs ensures greater precision, and it yields a reduced workload for anaesthesiologist and a better readability than hand-written text. However, some issues remain, and new ones have been introduced. For instance, the electronic interface is by nature less flexible than paper, and often more verbose. Furthermore, due to the spatial constraints of the operation theatre, the screen of the electronic anaesthesia record in often placed behind the anaesthesiologist, making it difficult to see both the record and the patient at once. Finally, during crisis situations when the focus must be kept on the patient, registration is necessarily postponed, leading to gaps and inaccuracies in the record, which may affect patient safety. This calls for an improvement of the user interface, in particular during crisis situations.

2 Speech recognition in hospitals

Speech recognition – i.e. the possibility to talk to a computer – comes in roughly two flavours. The first type ("command mode") makes the computer "understand" and react appropriately, as long as the user utilises a predefined, constrained language (e.g. keywords). The second type ("free text mode") allows the dictation of natural language sentences, although primarily within a given context of discourse; this mode is less suited to deliver any "smart" reaction to such input.

Today, most of the major natural languages of Europe are supported [2], but each language has its specificities and may work better or worse than others depending on the situation.

Speech recognition as a medical transcription tool is now common in hospitals and is steadily increasing [3]. A smaller proportion of the use cases involve medical equipment that is able to react to voice commands (e.g. surgeon assistant robots).

3 Speech recognition during anaesthesia

In the case of the anaesthesia record, speech recognition has been proposed as a supplementary modality (i.e. communication channel) in addition to the existing typical touch-screen and keyboard input [4,5,6]. Thus, speech recognition is not intended to replace existing input modalities, but to provide another possibility to be used when suited. The main goals of the speech interface are:

- to improve the visual contact with the patient by allowing hands-free registration
- to collect data more accurately
- to lessen anaesthesiologists' cognitive load burden (trying to memorize medications) during crisis situations

The speech recognition interface can accept commands for the computer to register appropriately medications and most standard procedures. A free text mode can also be provided to enable the dictation of ad-hoc non-structured remarks.

One of the first questions [1] that come to mind is about the impact of the background noise found in an operation room [7]. Experiments have shown that the type of microphone is of major importance when the level of noise rises, and that a suitable microphone may counteract the negative effects of noise, at least for "commands", since "free text" is more sensitive to such disturbance. In this regard, the list of possible commands should also be chosen with great care and phonetics considerations.

Supporting the above considerations, some experiments have been made [8] in September 2006 in a full scale anaesthesia simulator at Herlev Hospital (Copenhagen, Denmark), with some skilled anaesthesiologists facing crisis scenarios (e.g. anaphylactic shock, cardiac arrest). The experiments were partially "Wizard-of-Oz" (i.e. with some human assistance) due to the limited time available to train the participants. First of all, the results show that with the normal electronic interface, the queue of events or actions (typically, medications) waiting to be become registered increases as the scenario develops (Figure 1). This suggests that the normal touch-screen and keyboard interface is too slow when the anaesthesia team experiences a crisis. When speech recognition was enabled, the registration of the events in the anaesthesia record could be achieved with virtually no queue, i.e. no actions "waiting" to become registered. Indeed, 98.7% of the medicaments were correctly recorded by the end of the session when using speech input, as opposed to only 56% when the conventional touch-screen and keyboard interface was the only option available.

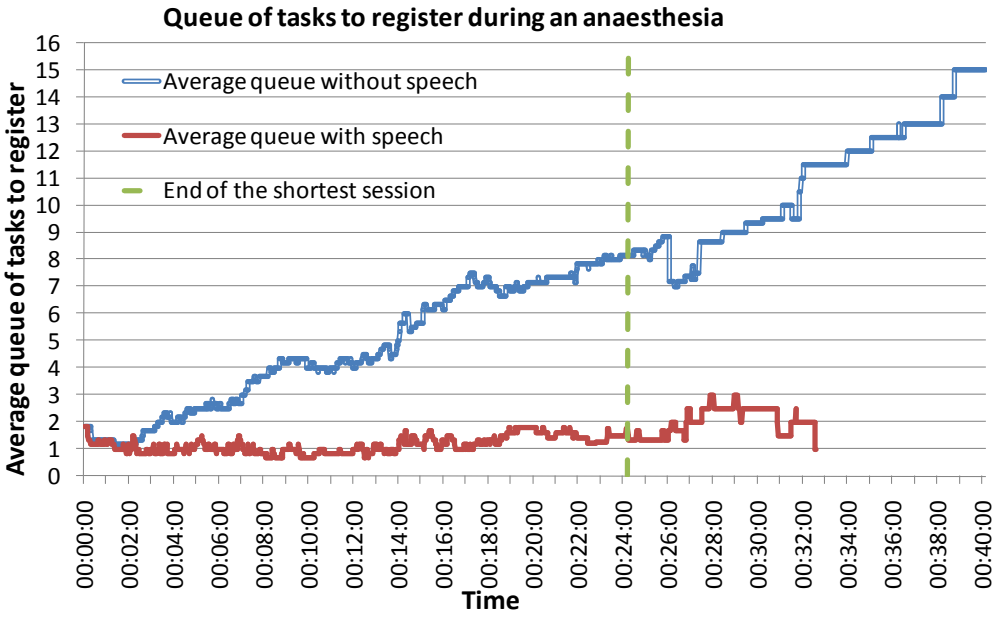

Figure 1: Evolution of the averaged queue of events to register during the anaesthesia scenarios, with or without voice. [8]

An analysis of the behaviour of anaesthesia doctors and nurses during the experimental scenarios shows that when they can use speech input, they need a bit less time to fill-in the record, but more interestingly, most of the registration by voice was done while doing something else with the patient (Figure 2).

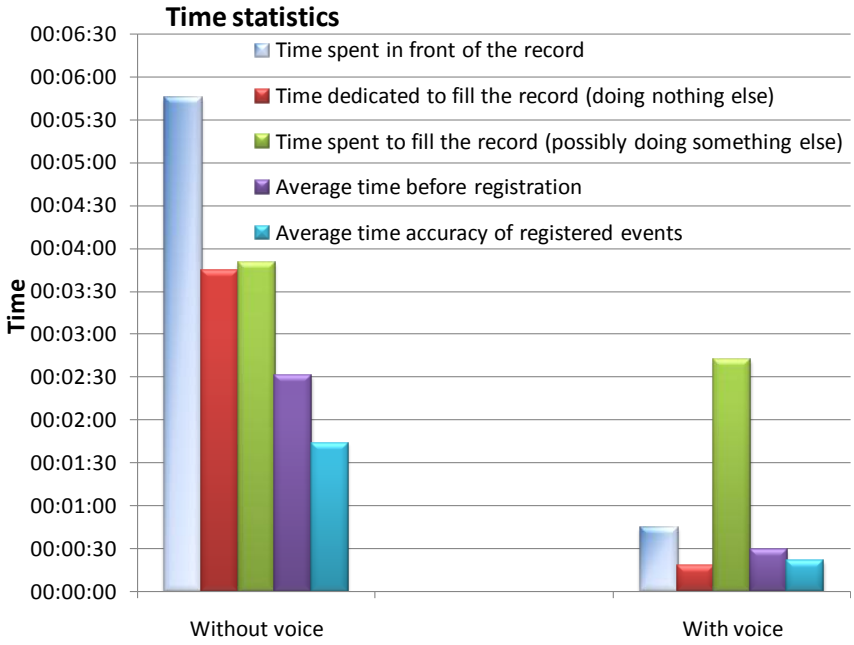

Figure 2: Measurements of delays and time used to fill the anaesthesia record, with or without voice. [8]

While these results appear so far to support speech recognition, the reader should be warned that the speech recognition rates (the percentage of inputs properly recognised by the computer) are far from perfect and are highly dependent on the training and willing of the users. Therefore, a substantial development time and user commitment must be expected before reaching satisfying results [9].

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